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EXAMINER

IM, JUNGHWA M

ART UNIT PAPER NUMBER

2811

DATE MAILED: 11/06/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/945,065

Applicant(s)

DERAA ET AL.

Examiner

Junghwa M. Im

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 13 August 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-35 is/are pending in the application.
- 4a) Of the above claim(s) 21-35 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Election/Restrictions***

Applicant's election without traverse of claims 1-20 in Paper No.6 is acknowledged.

Claims 21-35 are cancelled.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claim 5 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 5 recites the less amount of chlorine content in the metal silicide adhesion layer than the second portion of the metal layer. The specification does not teach how to make layers having the relative chlorine content recited.

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in-

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(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

Claim 14 is rejected under 35 U.S.C. 102(e) as being anticipated by Taguwa (U.S. Pat. No. 6,404,058).

Regarding claim 14, Taguwa discloses in Fig. 3C, a high aspect ratio contact structure formed over a junction region in a silicon substrate 201, comprising:

an insulating layer 204, wherein the insulating layer defines a contact opening, wherein the contact opening is formed over the junction region 203 of the substrate;

a titanium layer 209 formed in and adjacent the contact opening, wherein a portion of the titanium layer is formed on the insulating layer;

a titanium silicide adhesion layer 210 formed on an upper surface of the titanium layer;

a titanium nitride contact fill 211 formed in and adjacent the opening, wherein the titanium nitride 211 is formed on an upper surface of the titanium silicide adhesion layer 212, wherein the titanium silicide adhesion layer adheres the titanium nitride contact fill to the portion of the titanium layer.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

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having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-7, 9-14 and 16-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguwa (U.S. Pat. No. 6,404,058) in view of Thakur et al.(U.S. Pat. No. 6,262,485).

Regarding claim 1, Taguwa shows in Fig.3C an integrated circuit comprising:

a silicon substrate 201;

an insulating layer 204 formed over the silicon substrate wherein the insulating layer has an opening that extends from an upper surface of the insulating layer to an upper surface of the substrate as to expose the upper surface of the substrate;

a metal layer 209 formed in the opening wherein a first portion of the metal layer is formed on the exposed upper surface of the substrate wherein a second portion of the metal layer does not contact the substrate and remains unreacted; and

a metal nitride layer 211 formed over the first and second portion of the metal layer in a manner such that a metal silicide adhesion layer 210 is interposed between the metal nitride 211 and the second portion of the metal layer so as to enhance adhesion between the metal nitride and the second portion of the metal layer.

Taguwa does not show a metal silicide layer formed in the exposed region of the substrate through the reaction of the metal layer with silicon.

However, Thakur et al. show a device with a contact hole forming a titanium silicide layer (530 in Fig. 5C) in a silicon substrate.

It would have been obvious to one of ordinary skill in the art at the time of the invention

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to modify the device of Taguwa with the teachings of Thakur et al. to decrease the ohmic resistance of a contact hole interconnection through forming a metal silicide region in a silicon substrate (col. 3, lines 62-64)

Regarding claim 2, Taguwa teaches in Fig. 3C the metal layer 209 comprises titanium.

Regarding claim 3, Taguwa teaches in Fig. 3C the metal nitride layer 211 comprises titanium nitride

Regarding claim 4, Taguwa teaches in Fig. 3C the metal silicide adhesion layer 210 comprises titanium silicide.

Regarding claim 5, Taguwa teaches a method of making the titanium and silicide layers that uses  $\text{TiCl}_4$  in a manner substantially the same as disclosed in Applicant's specification. If Applicant's layers have the relative chlorine content recited in claim 5, then Taguwa layers would also (col. 5, lines 2-5).

Regarding claim 6, Taguwa shows the metal silicide adhesion layer is approximately 50-150 angstrom thick ( col. 5, line 49).

Regarding claim 7, Taguwa shows in Fig. 3C the opening is a contact opening.

Regarding claim 9, Taguwa shows in Fig. 3C the exposed upper surface of the substrate comprises a junction region 203.

Regarding claim 10, Taguwa shows in Fig. 3C an integrated circuit comprising a contact fill 212, 213 formed on an upper surface of the titanium nitride layer wherein the contact fill substantially fills the contact opening.

Regarding claim 11, Taguwa shows in Fig. 3C the contact fill 213 comprises titanium nitride.

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Regarding claim 12, Taguwa shows the titanium nitride contact fill comprises  $\text{TiCl}_4$  based titanium nitride (col. 5, lines 55-57).

Regarding claim 13, Thakur et al. show the contact fill comprises tungsten to form a low resistance interconnect (col. 4, lines 6-7).

Claim 14 has been discussed previously.

Regarding claim 16, Taguwa shows the titanium nitride contact fill comprises  $\text{TiCl}_4$  based titanium nitride (col. 5, lines 55-57).

Regarding claim 17, Taguwa shows the insulating layer comprises BPSG (col. 2, lines 21-23).

Regarding claim 18, Taguwa shows the metal silicide adhesion layer is approximately 50-150 angstrom thick (col. 5, line 49).

Regarding claim 19, Thakur et al. teach to implant silicon within the titanium at the bottom of the contact hole (col. 7, lines 16-17). The silicide formed on annealing will therefore be interspersed in a titanium rich layer.

Regarding claim 20, Taguwa shows inherently the titanium silicide adhesion layer inherently comprises less chlorine than the titanium rich layer (col. 5, lines 2-51).

### ***Claim Rejections - 35 USC § 103***

Claims 8 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguwa and Thakur et al. as applied to claims 1 and 14 above, and further in view of Dixit et al.

Regarding claims 8 and 15, Taguwa and Thakur et al. show most aspect of pending claim except the recited limitation on an aspect ratio of the contact opening.

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However, Dixit et al show a device with a contact hole having an aspect ration of 10:1 (col. 3, line 64).


It would have been obvious to one of ordinary skill in the art at the time of the invention to modify an aspect ratio of the contact hole with the teaching of Dixit et al. since a contact hole with such an aspect ratio complies the current trend of the effort to minimize the size of the memory cell and improve the reliability of interconnection metals.

### *Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Junghwa M. Im whose telephone number is (703) 305-3998. The examiner can normally be reached on MON.-FRI. 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (703) 308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

  
Sara Crane  
Primary Examiner

JMI  
November 2, 2002